Ichthyofauna of the Colorado and Green Rivers in Canyonlands National Park, Utah

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Abstract. Thirty-one species of fish were found in the Colorado and Green rivers in and adjacent to Canyonlands National Park during 1985–88 in the first intensive ichthyofaunal survey of the area. We found 8 native species (5% of total number) and 23 nonnative species (95%). The four species of endemic mainstem fishes that are federally classified as endangered were present—Colorado squawfish (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*G. elegans*), and razorback sucker (*Xyrauchen texanus*). Numerous age-0 (young-of-year) Colorado squawfish were found as were small numbers of juveniles and adults. A reproducing population of humpback chub was confirmed in Cataract Canyon, and six suspected bonytail were found. Only one adult razorback sucker was captured. Endemic roundtail chub (*G. robusta*) and flannelmouth sucker (*Catostomus latipinnis*), as well as native bluehead sucker (*C. discobolus*) and speckled dace (*Rhinichthys osculus*), were also present in low numbers. The most common species in backwaters and shorelines were nonnative red shiners (*Cyprinella lutrensis*), sand shiners (*Notropis stramineus*), and fathead minnows (*Pimephales promelas*), while channel catfish (*Ictalurus punctatus*) and common carp (*Cyprinus carpio*) were the dominant main channel species.

Key words: Bonytail, Canyonlands National Park, Cataract Canyon, Colorado River endangered fish, Colorado River ichthyofauna, Colorado squawfish, humpback chub, razorback sucker.

Our purpose was to characterize the ichthyofauna of the Colorado and Green rivers in and adjacent to Canyonlands National Park (CNP) and to assess the importance of the area to the endangered Colorado River fishes: Colorado squawfish (*Ptychocheilus lucius*), humpback chub (*Gila cypha*), bonytail (*G. elegans*), and razorback sucker (*Xyrauchen texanus*). The objectives of the investigation were to

1. assess the distribution and relative abundance of all fish species,
2. determine spawning locations and nursery areas of endangered fishes, and
3. confirm the existence of a population of humpback chub in Cataract Canyon.

The Colorado and Green rivers in and adjacent to CNP are among the last reaches of the upper Colorado River to be intensively surveyed for fishery resources. Valdez et al. (1982) first sampled the area from 1979 through 1981 and reported numerous young Colorado squawfish, small numbers of humpback chub, and large numbers of nonnatives. The area received much attention in April 1980 when 45 adult Colorado squawfish were captured in the Lake Powell inflow as part of an investigation of striped bass (*Morone saxitilis*; Persons et al. 1982). As a result of these findings, the Bureau of Reclamation radio-tagged adult Colorado squawfish in the inflow from 1982 to 1985 in an attempt to locate fish concentrations, monitor movements, and identify possible spawning areas. The investigation we describe began as a pilot study in Cataract Canyon in 1985 to identify Colorado squawfish spawning sites and to confirm a reproducing population of humpback chub. From 1986 through 1988, the investigation was expanded to characterize the ichthyofauna of the lower 80 km of the Colorado and Green rivers above their confluence; the Colorado River through Cataract Canyon; and the Lake Powell inflow (Valdez 1990).

Study Area

This investigation was conducted on the Colorado River in Utah from Potash (river kilometer [RK] 80) downstream to Imperial Canyon in upper Lake Powell (RK 316, 34 km below the confluence of the Colorado and Green rivers), as well as that portion of the Green River from Mineral Bottom (RK 80) downstream to the confluence (Fig. 1). This area represents the lowermost free-flowing reach of the upper Colorado River basin (i.e., above Lees Ferry). Detailed maps of the Colorado and Green rivers in this area are available in two river guides (Belknap and Belknap 1974; Baars 1987). Distances above the confluence are measured in river kilometers from that point while distances below the confluence are measured from Lees Ferry (i.e., the confluence is 350 km upstream of Lees Ferry).

The Colorado and Green rivers in the study area flow through lands administered by the National Park Service (CNP and Glen Canyon National Recreation Area [GCNRA]) and the Bureau of Land Management, and they enter CNP 55 and 76 km upstream from their confluence, respectively. The river leaves CNP and enters GCNRA at RK 328, 22 km below the confluence. The Colorado River flowed into Lake Powell during this investigation between RK 325 (1,123 m elevation) and RK 326 (at a maximum lake elevation

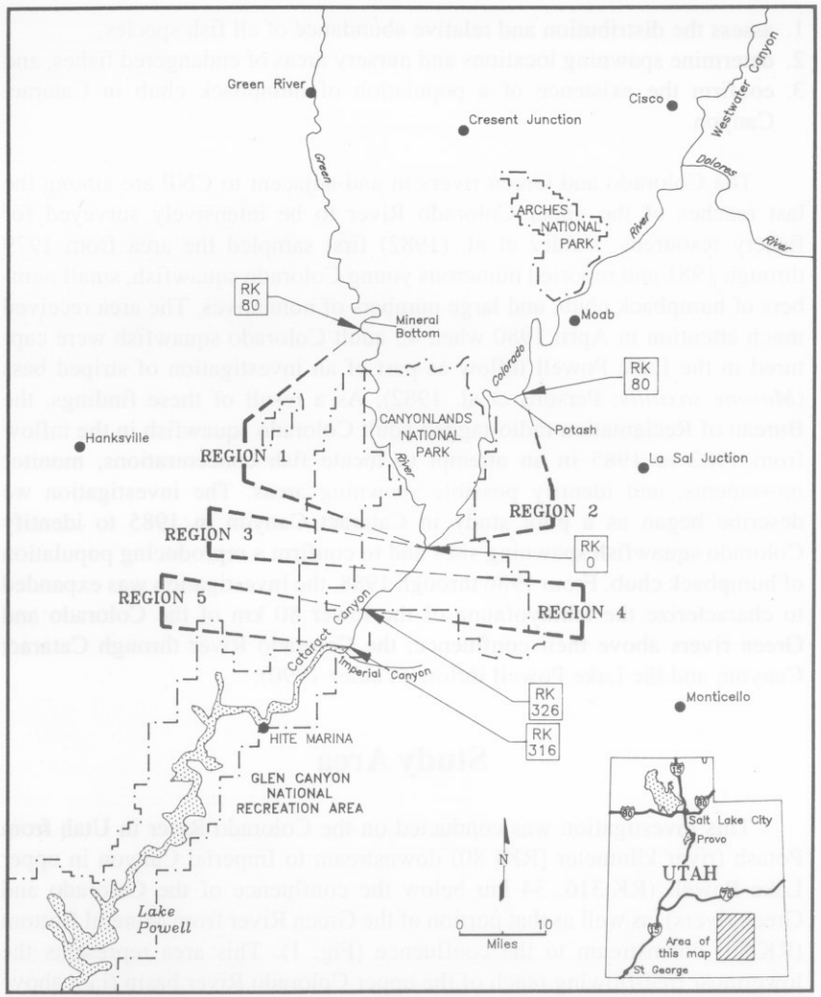

Fig. 1. Five study regions of the Colorado and Green rivers in and adjacent to Canyonlands National Park.

of 1,128 m), depending on lake level. The study area was divided into five regions:

Region 1—Green River, above the confluence with the Colorado River (RK 0–80);
Region 2—Colorado River, above the confluence with the Green River (RK 0–80);
Region 3—Confluence, to the first rapid in Cataract Canyon (RK 344–350);
Region 4—Cataract Canyon (RK 326–344); and
Region 5—Lake Powell inflow (RK 316–326).

The river in region 1 was low-gradient, meandering, and lined with tamarisk (*Tamarix* spp.) and willow (*Salix* spp.), with a primarily sand and silt substrate and intermittent deposits of alluvial cobble and rock outcrops. The river in region 2 was similar with a greater proportion of sand substrate. In region 3, the river was a continuation of this channel geomorphology between the confluence and Cataract Canyon, whereas in region 4 (Cataract Canyon), the river was unique for the only extensive rocky habitat for more than 150 km upstream. It was also the deepest region in the upper basin, with a maximum water depth of 30 m at RK 341 (Valdez et al. 1982). Region 5 consisted of deep deposits of silt and sand, which filled lower Cataract Canyon in the Lake Powell inflow.

Fish habitat in each region was largely determined by shoreline type, because much of the main channel had a shifting sand bottom with little cover for fish. Five types of shorelines were classified including (1) tamarisk–willow, (2) talus–scree, (3) rock ledges, (4) vertical walls, and (5) sand beaches. The tamarisk–willow habitat was the most common, particularly along silt and sand banks in regions 1, 2 and 3. This habitat was characterized by dense growths of tamarisk and willow with overhanging and submerged branches and root wads. Talus–scree habitat was present below steep unconsolidated slopes where boulders and other colluvial materials had spilled into the river, sometimes forming large whitewater rapids. This habitat was prevalent in region 4 and occurred intermittently in regions 1, 2, and 3. The boulder and cobble jetties formed by these talus slopes created large eddies with sandy reattachment bars and associated eddy return channels (backwaters) that were important fish habitat. Rock ledge habitat was present where low walls of metamorphic or igneous rock overhung the river in the lower reaches of regions 1 and 2. These ledges were characterized by depressions and pockets worn by water action and were good fish habitat when associated with rock substrate. Shifting sand substrate provided little cover and low productivity; reducing the fish habitat value of rock ledges, particularly for native roundtail chub (*Gila robusta*)—a species with close affinity for rock substrate (Valdez et al. 1982). Vertical wall habitat was prevalent in the lower reaches of regions 1 and 2 and throughout region 4. This habitat was created by steep, high walls of sedimentary or metamorphic rock that emerged from below the water surface. These smooth walls had few irregularities, and the absence of an associated rock substrate negated their value as lateral cover for chubs. Sand beach habitat generally had an associated shifting sand bottom and usually formed the banks of nursery backwaters. This shoreline habitat was common in regions 1 and 2 but occurred intermittently in regions 3, 4, and 5.

Flow and temperature of the Colorado and Green rivers varied dramatically during our investigation. Before the study, record high flows of about

2,800 cubic meters per second (cms) occurred in Cataract Canyon in 1983 and 5,600 cms in 1984. These 2 record water years were followed by 2 normal years (1985 and 1986), but peak and base flows remained high because of high soil moisture content. Flows in Cataract Canyon in 1985 peaked in May at about 1,750 cms, while base flows generally remained above 280 cms. In 1986, flows peaked in June at about 1,980 cms, and base flows also remained around 280 cms. Peak flows in May 1987 reached 1,130 cms; the peak in 1988 was 790 cms. Base flows approximated 140 cms during these dry years. During the higher water years, water temperatures did not reach 20° C until early June in 1985 and mid-June in 1986. In 1987 and 1988, this temperature was recorded by mid-May.

Methods

Six field trips were conducted annually in 1985 and 1986, eight in 1987, and nine in 1988. Sampling was conducted in every month, except during spring runoff in May–June and during winter in November–February. Access to the study area was by motorized rafts from launch sites at either Potash on the Colorado River or Mineral Bottom on the Green River. The takeout was at Hite Marina on Lake Powell, about 160 km downstream. Launch sites were alternated between the Colorado and Green rivers to systematically sample all five regions.

Fish were sampled by a variety of means, including electrofishing, gill nets, trammel nets, seines, minnow traps, hoop nets, larval drift nets, kick screens, and dip nets. Native fish were counted and individually measured, weighed, and released. Nonnative fish were counted and individually measured and weighed (when captured in small numbers) or subsampled for lengths and weights (when captured in large numbers). Catch per unit effort (CPUE) was computed for each species by gear type as number of fish/10 h of electrofishing, number/30 m of gill or trammel net/100 h, number/100 m^2 seined, or number/10 h of minnow traps or hoop nets. Larval drift nets were assessed as number of fish/10 m^3 of water filtered, and fish captured by kick screens and dip nets were expressed as number captured by effort. All data were recorded on field data sheets using the upper Colorado River basin data base codes and later electronically stored as dBASE III+ files.

Endangered fish longer than 175 mm total length (TL) were marked with serially numbered Carlin dangler tags attached to the musculature at the base of the dorsal fin (Valdez et al. 1981). Humpback chub, roundtail chub, and suspected bonytail were distinguished by field examination of morphological characters and field photographs and measurements used for later examination. Morphological characters were mouth overhang, jaw length, nuchal hump, skull depression, caudal peduncle angle, nuchal scalation, and breast scalation (Douglas et al. 1989). Morphological ratios included dorsal:anal fin-ray count, caudal peduncle length divided by head length, and head length divided by caudal peduncle depth (Minckley 1973). Chubs longer than 175 mm TL were individually photographed on a centimeter grid board and measured afield for (1) total length, (2) fork length, (3) distance between insertions of pectoral and pelvic fins, (4) nuchal depth, (5) minimum caudal peduncle depth, (6) caudal peduncle length, (7) head length, (8) length of dorsal fin base, (9) length of anal fin base, (10) dorsal and anal fin-ray counts, (11) maximum caudal peduncle depth, (12) maximum body depth, and (13) snout length. These measurements were analyzed using principal components analysis (Humphries et al. 1981) and, together with the morphological characters and ratios, were used to distinguish the three species of chubs—*Gila cypha*, *G. elegans*, and *G. robusta*. Specimens that could not be definitively identified to species were classified as *Gila* sp.

Species Composition

Thirty-one species of fish, including 23 nonnative and exotic and 8 native species, were found in the study area from 1985 through 1988 (Table 1). All four species of mainstem endangered fishes were captured, including humpback chub, bonytail, Colorado squawfish, and razorback sucker. These four species accounted for fewer than 6% of individuals captured in any given year of the study and about 3% overall. Of the eight native species, six were endemic—humpback chub, bonytail, roundtail chub, Colorado squawfish, flannelmouth sucker (*Catostomus latipinnis*), and razorback sucker—and two were native but not endemic—speckled dace (*Rhinichthys osculus*) and bluehead sucker (*C. discobolus*). The eight native species collectively ranged from less than 1 to 19% of the total catch by region (Table 2).

Numerically, nonnative species made up 95% of the fish encountered in all years combined, while the eight native species made up only 5% (Fig. 2). Five nonnative species—red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramineus*), channel catfish (*Ictalurus punctatus*), common carp (*Cyprinus carpio*), and fathead minnow (*Pimephales promelas*)—accounted for 90% of the catch. Red shiners outnumbered all other species in region 1 (Green River), region 3 (Confluence), region 4 (Cataract Canyon), and region 5 (Lake Powell). This species was abundant in shallow, protected areas with silt and sand substrate. Sand shiners were dominant in region 2 (Colorado River), where sand substrate was predominant.

Nonnative species accounted for 80 to 99% of the fish caught by region (Table 2). The greatest percentage of nonnative species caught was in region 5, where both lacustrine and riverine species were abundant. Species that were present in region 5—but rare or absent in the riverine habitat of regions 1–4—included black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), smallmouth bass (*Micropterus dolomieui*), threadfin shad (*Dorosoma petenense*), walleye (*Stizostedion vitreum*), and striped bass.

Table 1. Origin and status of fish species encountered in the Colorado and Green rivers in and adjacent to Canyonlands National Park, 1985–1988.

Scientific name	Common name (Species code)	Origin[a]	Status[b] State	Federal
Family Clupeidae: herrings				
Dorosoma petenense	threadfin shad (TS)	NN	NG	
Family Cyprinidae: carps and minnows				
Cyprinella lutrensis	red shiner (RS)	NN	NG	
Cyprinus carpio	common carp (CP)	EX	NG	
Gila atraria	Utah chub (UC)	NN	NG	
Gila cypha	humpback chub (HB)	EN	ED	ED
Gila elegans	bonytail (BT)	EN	ED	ED
Gila robusta	roundtail chub (RT)	EN	TH	C2
Gila sp.	unidentified chub (CH)	—	—	—
Hybognathus hankinsoni	brassy minnow (BM)	NN	NG	
Notropis stramineus	sand shiner (SS)	NN	NG	
Pimephales promelas	fathead minnow (FH)	NN	NG	
Ptychocheilus lucius	Colorado squawfish (CS)	EN	ED	ED
Rhinichthys osculus	speckled dace (SD)	NA	NG	
Family Catostomidae: suckers				
Catostomus commersoni	white sucker (WS)	NN	NG	
Catostomus discobolus	bluehead sucker (BH)	NA	NG	
Catostomus latipinnis	flannelmouth sucker (FM)	EN	NG	C2
Xyrauchen texanus	razorback sucker (RZ)	EN	ED	ED
Family Ictaluridae: bullheads and catfishes				
Ameiurus melas	black bullhead (BB)	NN	NG	
Ictalurus punctatus	channel catfish (CC)	NN	GF	
Family Esocidae: pikes				
Esox lucius	northern pike (NP)	NN	GF	
Family Salmonidae: trout				
Oncorhynchus mykiss	rainbow trout (RB)	NN	GF	
Oncorhynchus nerka	kokanee salmon (KS)	NN	GF	
Salmo trutta	brown trout (BR)	EX	GF	
Family Cyprinodontidae: killifishes				
Fundulus zebrinus	plains killifish (PK)	NN	NG	
Family Poeciliidae				
Gambusia affinis	western mosquitofish (GA)	NN	NG	
Family Percichthyidae: temperate basses				
Morone saxatilis	striped bass (SB)	NN	GF	
Family Centrarchidae: sunfishes				
Lepomis cyanellus	green sunfish (GS)	NN	NG	
Lepomis macrochirus	bluegill (BG)	NN	GF	
Micropterus dolomieu	smallmouth bass (SM)	NN	GF	
Micropterus salmoides	largemouth bass (LG)	NN	GF	
Pomoxis nigromaculatus	black crappie (BC)	NN	GF	

Table 1. *Continued.*

Scientific name	Common name (Species code)	Origin[a]	Status[b] State	Federal
Family Percidae: perches				
Stizostedion vitreum	walleye (WE)	NN	GF	

[a] EN = endemic, indigenous to basin; EX = exotic, from another continent; NA = native, originated in basin; NN = nonnative, from another North American basin.
[b] C2= candidate, category 2; ED = endangered; GF = game or sport fish; NG = nongame fish; TH = threatened.

Distribution and Abundance of Native Species

Colorado Squawfish

Colorado squawfish were found in all five regions of the study area (Table 2). A total of 4,348 individuals were captured, including 385 larvae, 3,776 age-0 (young-of-year), 175 juveniles (preadults), and 12 adults. The greatest number of larvae were captured in region 1 (266), with far fewer in regions 2 (1), 3 (37), 4 (60), and 5 (21). Most age-0 Colorado squawfish were captured in region 1 (2,132) and region 4 (1,149), with fewer from regions 2 (50), 3 (355), and 5 (90). All larval and age-0 Colorado squawfish were captured in backwaters and shallow, low-velocity shoreline habitats. Of 3,144 larvae and age-0 seined—mostly from backwaters—the highest catch rates of 61.9/100 m^2 in 1986 and 71.6 in 1987 were from region 1 (Table 3). The relatively high number of age-0 and high catch rate (31.6/100 m^2) in region 4 in 1988 were attributed to a large rain-induced flood in the lower Green River that transported large numbers of squawfish into Cataract Canyon. The lower Green River and Cataract Canyon were coincidentally sampled before and after the rain storm to confirm these observations.

Of 175 juvenile Colorado squawfish, the greatest number (65) was captured in region 1, while fewer individuals were caught in regions 2 (32), 3 (36), 4 (38), and 5 (4). Juveniles were found in a variety of habitats, but the majority were captured with seines in backwaters associated with sand beaches and along talus–scree shorelines. The rest were captured with electrofishing and experimental gill nets near talus–scree shorelines.

Five adult Colorado squawfish were captured in region 4; fewer were captured in regions 1 (1), 2 (1), 3 (3), and 5 (2). Eight of the 12 adults were captured with electrofishing gear from tamarisk–willow and talus–scree shorelines, while 4 were captured with gill or trammel nets in eddies near talus–scree. The 12 fish averaged 519 mm TL (range of 425–662 mm TL) and 1,002 g body weight (range of 540–2,043 g). The ages of the adults and juveniles were not determined.

Two adult Colorado squawfish, captured in 1986, had been previously caught upstream of Cataract Canyon by the U.S. Fish and Wildlife Service

Table 2. Number (N) and percentage (P) of fish species captured by region in the Colorado and Green rivers in and adjacent to Canyonlands National Park, 1985–1988.

Species code[a]	Region 1		Region 2		Region 3		Region 4		Region 5		Total	
	N	P	N	P	N	P	N	P	N	P	N	P
TS	0	0	0	0	0	0	2	<0.1	172	0.5	174	0.1
RS	9,041	64.6	1,650	32.0	11,174	57.8	30,157	42.8	19,416	53.9	71,438	49.3
CP	116	0.8	237	4.6	621	3.2	3,339	4.7	4,245	11.8	8,558	5.9
UC	0	0	0	0	1	<0.1	0	0	0	0	1	<0.1
HB	4	<0.1	5	0.1	4	<0.1	93	0.1	2	<0.1	108	<0.1
BT	1	<0.1	0	0	0	0	5	<0.1	0	0	6	<0.1
RT	3	<0.1	21	0.4	32	0.2	240	0.3	24	<0.1	320	0.2
CH	9	0.1	13	0.3	28	0.1	443	6.3	42	0.1	535	0.4
BM	0	0	4	<0.1	0	0	3	<0.1	0	0	7	<0.1
SS	403	2.9	2,266	44.0	3,554	18.4	17,198	24.4	6,290	17.5	29,711	20.5
FH	910	6.5	286	5.5	1,534	7.9	3,140	4.5	1,018	2.8	6,888	4.8
CS	2,464	17.6	84	1.6	437	2.3	1,246	1.8	117	0.3	4,348	3.0
SD	50	0.4	27	0.5	69	0.4	752	1.1	43	0.1	941	0.7
WS	0	0	0	0	2	<0.1	1	<0.1	0	0	3	<0.1
BH	69	0.5	28	0.5	74	0.4	284	0.4	10	<0.1	465	0.3
FM	112	0.8	169	3.3	161	0.8	813	1.2	30	<0.1	1,285	0.9
RZ	0	0	1	<0.1	0	0	0	0	0	0	1	<0.1
BB	5	<0.1	3	<0.1	18	0.1	215	0.3	3	<0.1	244	0.2
CC	687	4.9	229	4.4	1,001	5.2	6,660	9.5	4,200	11.7	12,777	8.8
NP	0	0	0	0	0	0	3	<0.1	2	<0.1	5	<0.1
RB	0	0	0	0	1	<0.1	1	<0.1	0	0	2	<0.1
BR	1	<0.1	1	<0.1	0	0	0	0	1	<0.1	3	<0.1
KS	0	0	0	0	0	0	0	0	2	<0.1	2	<0.1

Table 2. *Continued.*

Species code[a]	Region 1		Region 2		Region 3		Region 4		Region 5		Total	
	N	P	N	P	N	P	N	P	N	P	N	P
PK	5	<0.1	2	<0.1	9	<0.1	15	<0.1	6	<0.1	37	<0.1
GA	1	<0.1	31	0.6	14	<0.1	42	<0.1	1	<0.1	89	<0.1
SB	0	0	0	0	0	0	40	<0.1	202	0.6	242	0.2
GS	5	<0.1	2	<0.1	13	<0.1	6	<0.1	6	<0.1	32	<0.1
BG	0	0	0	0	0	0	0	0	1	<0.1	1	<0.1
SM	0	0	0	0	0	0	0	0	1	<0.1	1	<0.1
LG	0	0	9	0.2	28	0.1	16	<0.1	17	<0.1	70	<0.1
BC	0	0	0	0	2	<0.1	2	<0.1	11	<0.1	15	<0.1
WE	0	0	1	<0.1	0	0	3	<0.1	66	0.2	70	<0.1
Total	13,886	100%	5,070	100%	18,777	100%	64,718	100%	35,928	100%	138,379	100%

[a] See Table 1 for common and scientific names.

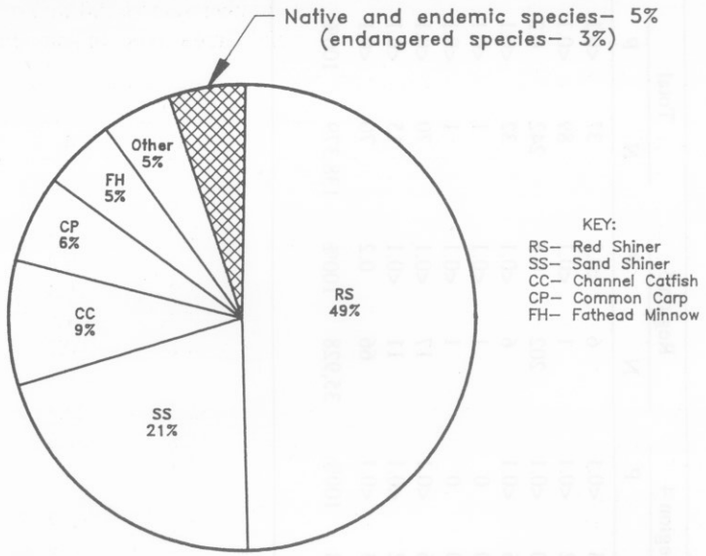

Fig. 2. Fish species composition of the Colorado and Green rivers in and adjacent to Canyonlands National Park, 1985–88.

(H. M. Tyus, U.S. Fish and Wildlife Service, Vernal, Utah, personal communication). One fish was tagged and released in the Green River on 28 April 1983 and recaptured, more than 39 months later, 279 km downstream on 14 August 1986 (14.6 km below the confluence of the Colorado and Green rivers). This fish was 398 mm TL and weighed 498 g at first capture and was 516 mm TL and weighed 907 g when recaptured—a size increase of 118 mm and 409 g. The other fish was tagged and released in the Green River on 4 May 1983 and recaptured, more than 38 months later, 194 km downstream on 11 July 1986 (at the confluence of the Colorado and Green rivers). This fish was 438 mm TL and weighed 620 g at first capture and was 500 mm TL and 794 g when recaptured—an increase of 62 mm and 174 g.

Colorado squawfish spawning sites were not confirmed during this investigation, despite intensive sampling for spawning fish, eggs, and larvae during suspected spawning times in June and July. Suspected spawning sites, based on distribution of larvae, were located in Cataract Canyon (RK 332) and at various alluvial cobble bars in the Green and Colorado rivers. McAda and Kaeding (1991) hypothesized that spawning areas for Colorado squawfish in the Colorado River were widely distributed and that seasonal movements of adults to those areas were relatively short.

Humpback Chub

One hundred eight humpback chub were captured during this investigation, including 11 larvae, 19 age-0, 56 juveniles, and 22 adults. Of the 108

Table 3. Catch per unit effort (CPUE as number seined/100 m^2) of the six most common species in the Colorado and Green rivers in and adjacent to Canyonlands National Park, 1985–1988.

	Region				
Species	1	2[a]	3	4	5
		1985			
Red shiner	102.9		80.0	15.9	161.7
Sand shiner	0.9		7.8	2.8	12.4
Fathead minnow	1.9		3.3	3.8	12.6
Channel catfish	14.6		6.8	10.4	7.9
Colorado squawfish[b]	14.1		2.7	1.5	1.6
Common carp	0		0.1	0.2	0.8
		1986			
Red shiner	57.2		85.7	23.4	204.3
Sand shiner	32.7		81.7	37.4	82.0
Fathead minnow	27.7		29.6	22.2	9.8
Channel catfish	15.4		68.0	32.7	3.5
Colorado squawfish[b]	61.9		13.2	4.8	0.4
Common carp	1.2		1.5	2.8	0
		1987			
Red shiner	319.3	121.5	219.6	135.6	167.4
Sand shiner	4.1	284.6	14.4	11.1	88.6
Fathead minnow	41.9	53.1	27.8	10.7	10.1
Channel catfish	20.4	10.1	9.1	38.0	20.9
Colorado squawfish[b]	71.6	1.9	8.6	2.5	2.3
Common carp	1.6	0.2	1.6	0.2	0.4
		1988			
Red shiner	83.3	212.6	490.5	521.8	616.2
Sand shiner	1.9	438.1	189.1	371.9	795.0
Fathead minnow	4.0	108.6	68.1	70.4	99.2
Channel catfish	1.2	12.2	11.9	42.0	25.7
Colorado squawfish[b]	20.4	4.3	14.8	31.6	14.0
Common carp	0.5	0.6	7.2	0.5	1.0

[a] Region 2 was not sampled in 1985 and 1986.
[b] Includes larvae and age-0 only.

chub, 93 (86%) were found in region 4 (Cataract Canyon), including 7 larvae, 13 age-0, 52 juveniles, and 21 adults. Before our study, only small numbers of adult humpback chub had been found in Cataract Canyon, and the presence of a reproducing population remained unconfirmed (Valdez et al. 1982; Valdez and Clemmer 1982). A defined age structure (i.e., larvae, age-0, juveniles, adults) and adults in pre- and postreproductive condition (i.e., milting males, tubercled males and females) confirmed the presence of a reproducing population of humpback chub in Cataract Canyon. This population was distributed from RK 324 to RK 343 in the whitewater region of Cataract Canyon, with the major concentration between RK 332 (rapid 13)

and RK 339 (rapid 8; rapid numbers from Belknap and Belknap 1974). This region was characterized by whitewater rapids, large eddies, and intervening pools and runs. All chub captured in region 4 were along talus–scree shorelines with emergent boulders. Some age-0 fish were captured in backwaters, and numerous juveniles were caught in small, isolated sand beaches within talus–scree shorelines.

Of 16 humpback chub captured outside of Cataract Canyon, 4 age-0 fish were found in region 1; 2 larvae, 2 juveniles, and 1 adult were found in region 2; 1 larva, 1 age-0, and 2 juveniles were found in region 3; and 1 larva and 1 age-0 were found in region 5. The larvae and age-0 chubs in regions 1–4 were captured in backwaters, and the juveniles and adults were along talus–scree or rock ledge shorelines. The absence of adults in region 1 suggests that young fish were transported from upstream populations in Desolation and Gray canyons, while the young fish in regions 2 and 3 may have been transported from upstream populations in Westwater Canyon and Black Rocks. The young chubs in region 5 probably originated from spawning areas within Cataract Canyon.

Bonytail

Six chubs, tentatively identified as bonytails, were handled during this investigation (Table 2). Five adults were captured in region 4 in approximately the same area (between RK 332 and RK 339) inhabited by humpback chub. These fish were captured with humpback chub along talus–scree shorelines with emergent boulders. No distinction in habitat use could be made between humpback chub and the suspected bonytails. One possible larval bonytail—as identified by the Larval Fish Laboratory at Colorado State University (R. T. Muth, Larval Fish Laboratory, Fort Collins, Colorado, personal communication)—was captured in region 1.

Razorback Sucker

One adult razorback sucker (493 mm TL; 1,618 g) was captured, Carlin tagged, and released in the Colorado River (RK 5.8) at a large riffle at the mouth of Salt Creek (region 2). This fish was captured 11 September 1987 and was the only razorback sucker caught during the 4-year investigation. Before this survey, 2 adults were captured at the Slide (RK 2.3 and 2.4) in 1981 (Valdez et al. 1982), and 6 (1980) and 11 (1981) were captured at Gypsum Canyon in upper Lake Powell (RK 319). Two were captured at Spanish Bottom (RK 345) in 1980 (Persons et al. 1982). While 21 adult razorback suckers were captured from this reach in 1980 and 1981, only 1 was captured from 1985 through 1988—further evidence of the decline of the species in the upper Colorado River basin. Successful reproduction by this species appears limited in the upper basin, and the number of adults is decreasing (Osmundson and Kaeding 1991). Lanigan and Tyus (1989) estimated that only 948 adults (95% C.I. = 758–1,138) remained in 274 km of the Green River above Desolation Canyon.

Other Native Species

Larval and age-0 Colorado squawfish were the most abundant native species in backwaters of the lower Green River; flannelmouth suckers were the most common in the main channel and shorelines. The number of flannelmouth suckers found in the study area totaled 1,285—the most (813) were in region 4, although electrofishing and trammel net CPUE varied by region and year (Tables 4 and 5). This species was not as abundant as in the more rocky upstream reaches of the Colorado and Green rivers. Adult and juvenile flannelmouth suckers were captured along tamarisk–willow and talus–scree shorelines, and young were taken from backwaters and shallow riffles.

Bluehead suckers were found in low numbers in the study area. Of 465 fish captured, 284 were from talus–scree shorelines in region 4, and electrofishing CPUE was typically highest in regions 3 and 4 (Table 4). Bluehead suckers found in regions 1, 2, and 3 were primarily in riffles over alluvial cobble bars and were not commonly captured with trammel nets. Three specimens were classified as hybrids between flannelmouth suckers and bluehead suckers. Hybrids were previously reported in other regions of the upper basin (McAda 1977).

Most of the 320 roundtail chub were captured from region 4 (240). Adult and juvenile roundtail chub were taken from talus–scree, rock ledge, or vertical wall shorelines. Age-0 chubs were found in backwaters as well as along talus–scree shorelines. This species is more abundant in the upper reaches of the Colorado River.

Only 941 speckled dace were captured. Most (80%) were in shallow cobble–gravel riffles in region 4.

Distribution and Abundance of Nonnative Species

Of 23 nonnative species identified in this survey, 14 were considered riverine and 9 were primarily lacustrine (Tyus et al. 1982). The more common riverine species were red shiners, sand shiners, fathead minnows, channel catfish, and common carp—all with highest CPUE for seines, electrofishing, and trammel nets (Tables 3, 4, and 5). Plains killifish (*Fundulus zebrinus*), black bullheads (*Ameiurus melas*), mosquitofish (*Gambusia affinis*), and brassy minnows (*Hybognathus hankinsoni*) were usually found in small numbers in backwaters and isolated pools. Nearly 200 age-0 black bullheads were found tightly schooled in an isolated spring pool in region 4. This sighting confirms reproduction by this species in Cataract Canyon, although most bullheads in the Colorado River probably originate from riverside

Table 4. Catch per unit effort (CPUE as number electrofished/10 h) of the six most common species in the Colorado and Green rivers in and adjacent to Canyonlands National Park, 1985–1988.

	Region				
Species	1[a]	2	3	4	5
		1985			
Common carp		100.0	90.0	466.9	1,781.2
Channel catfish		12.5	25.6	47.5	3,607.1
Flannelmouth sucker		0	23.8	34.8	15.3
Bluehead sucker		0	1.3	1.7	0
Colorado squawfish		0	0.6	3.3	0
Humpback chub		0	0	2.8	0
		1986			
Common carp		14.4	106.7	67.5	2,846.7
Channel catfish		74.9	327.0	210.3	1,000.0
Flannelmouth sucker		14.4	41.3	49.1	3.2
Bluehead sucker		0	6.9	7.4	0
Colorado squawfish		2.9	24.1	0.5	0
Humpback chub		0	0	2.0	0
		1987			
Common carp	8.1	100.7	199.0	399.1	1,618.1
Channel catfish	123.1	69.2	113.7	302.4	539.0
Flannelmouth sucker	91.3	61.2	62.9	86.0	7.8
Bluehead sucker	31.4	12.4	26.4	30.3	0
Colorado squawfish	1.2	2.5	8.1	2.0	0
Humpback chub	0	1.2	2.0	4.2	0
		1988			
Common carp	321.2	107.2	561.0	155.2	2,898.7
Channel catfish	104.6	119.2	65.0	412.2	872.8
Flannelmouth sucker	31.8	59.6	81.3	24.0	7.0
Bluehead sucker	19.2	17.9	69.1	19.8	0
Colorado squawfish	3.2	6.0	0	6.4	0
Humpback chub	0	0	4.1	3.0	0

[a] Region 1 was not sampled in 1985 and 1986.

ponds, such as abandoned gravel pits near Grand Junction, Colorado (Valdez and Wick 1983).

Lacustrine species were rare in riverine habitat above the Lake Powell inflow, except for green sunfish (*Lepomis cyanellus*) and largemouth bass (*Micropterus salmoides*), which were found in large backwaters and isolated pools. Although walleye (*Stizostedion vitreum*) were numerous in region 5, only three were captured in region 4 and one in region 2. The only Utah chub (*Gila atraria*) captured was at the confluence of the Colorado and Green rivers. Four black crappie and four rainbow trout (*Oncorhynchus mykiss*)

Table 5. Catch per unit effort (CPUE as number/30 m of trammel net/100 h) of the five most common species in the Colorado and Green rivers in and adjacent to Canyonlands National Park, 1985–1988.

	Region				
Species	1[a]	2	3	4	5
		1985			
Common carp		0	73.5	27.5	68.4
Channel catfish		0	36.8	4.8	5.5
Flannelmouth sucker		0	36.8	13.1	3.3
Bluehead sucker		0	0	0	0
Colorado squawfish		0	0	0.4	0
		1986			
Common carp	7.3	0	6.1	1.6	428.2
Channel catfish	0	14.0	12.2	0.8	23.1
Flannelmouth sucker	12.1	17.5	2.8	2.6	0
Bluehead sucker	0	0	0	0.1	0
Colorado squawfish	0	0	0	0.1	0
		1987			
Common carp	0.1	4.0	40.3	7.8	2,051.3
Channel catfish	0.1	0	11.9	1.3	0
Flannelmouth sucker	0	4.0	9.5	2.1	0
Bluehead sucker	0	0	0	0	0
Colorado squawfish	0	0	0	0	0
		1988			
Common carp	62.0	68.0	106.4	6.5	189.4
Channel catfish	43.1	0	53.2	1.1	78.9
Flannelmouth sucker	28.6	34.0	53.2	0.7	15.8
Bluehead sucker	0	0	0	<0.1	0
Colorado squawfish	0	0	0	<0.1	0

[a] Region 1 was not sampled in 1985.

were captured above the Lake Powell inflow. Bluegill, smallmouth bass, and threadfin shad were found only in the Lake Powell inflow.

Common carp were seen in large aggregations below the last major rapid of Cataract Canyon (rapid 23, Big Drop 3) each summer during the study, indicating that this species spawned in the riverine environment of the canyon and resided in the lake. Large numbers of ripe and gravid carp occurred in Cataract Canyon, but very few young carp were found. Either reproductive success was low or the young drifted back to Lake Powell. All life stages of channel catfish were found in large numbers in regions 4 and 5, indicating widespread reproduction in Cataract Canyon and the Lake Powell inflow.

Two juvenile striped bass captured in Cataract Canyon (region 4) are the only records of the species from the Colorado River above Lake Powell. One fish (TL = 388 mm) was caught on 4 August 1988 at RK 335.7 (above rapid 12) or 8.4 km above rapid 23 (RK 327.2). The rapid appeared to be a barrier

to most striped bass because large springtime aggregations were present at the base of the rapid. A second fish (TL = 362 mm) was caught on 10 August 1989 at RK 335.8, and a third fish was sighted but not captured on 28 September 1988 in the Colorado River 4.7 km above its confluence with the Green River. These records indicate that very few striped bass ascended the Colorado River above rapid 23 of Cataract Canyon during our study.

Five adult northern pike (*Esox lucius*) and two adult kokanee salmon (*Oncorhynchus nerka*) were unexpected captures from the study area. Three northern pike were captured in region 4, and two kokanee salmon were captured in region 5. Because these species have not been recently introduced into Lake Powell by resource agencies (R. Radant, Utah Division of Wildlife Resources, Salt Lake City, personal communication), their occurrence in this part of the Colorado River was probably the result of extensive movement from impoundments located several hundred kilometers upstream. The northern pike may have originated in Elk Head Reservoir (810 km upstream of Cataract Canyon) near the Yampa River in Colorado or from Taylor Park Reservoir (650 km upstream) on the Gunnison River in Colorado. The kokanee salmon probably originated from either Flaming Gorge Reservoir on the Green River (650 km upstream) or the Wayne Aspinall Units on the Gunnison River (560 km upstream).

Small numbers (<25) of virile crayfish (*Orconectes virilis*) were found in the Colorado River in CNP. These crustaceans are expanding in distribution and abundance throughout the state of Utah (Johnson 1986). Virile crayfish probably invaded CNP recently from either Lake Powell or upstream riverside ponds because they were not reported from the area in 1981 (Valdez et al. 1982). Although the crayfish may prey on young native fishes in nursery backwaters, they may be important in the diet of river otters (*Lutra canadensis*) because their remains dominate the content of otter scat from the area (B. Bates, Utah Division of Wildlife Resources, Price, personal communication).

Discussion

The Colorado and Green rivers in and adjacent to CNP are the lowermost free-flowing reaches of the upper Colorado River basin and provide important habitat for native and endangered ichthyofauna. The lower 80 km of the Green River may be part of the most important nursery area for age-0 Colorado squawfish in the basin, as indicated by relatively high fish densities in backwaters. Similarly, the Colorado River in Cataract Canyon is one of the most important areas in the basin for chubs. This region contains the most recently discovered reproducing population of humpback chub. It is one of only three areas in the upper basin where bonytail have been recently reported: one bonytail was reported from Black Rocks in 1984 (Kaeding et al. 1986) and two from Desolation Canyon in 1985 (M. Moretti, Utah Division of Wildlife Resources, Price, personal communication).

Significant reproduction by Colorado squawfish may occur in yet unidentified sites in the lower Green River and Cataract Canyon, based on relatively high densities of larvae and age-0 fish in local backwaters. Many of these fish may also be transported into these riverine regions or into Lake Powell from upstream spawning sites. Because flow volume in this region is significantly affected by Flaming Gorge Dam, about 580 km upstream of CNP, operation of this mainstem facility should be managed to maximize availability of nursery backwaters and to reduce downstream transport of young fish into Lake Powell. The numbers of young native fishes annually transported into this reservoir is unknown, but larvae and age-0 Colorado squawfish, flannelmouth suckers, bluehead suckers, and speckled dace are common in drift from other regions of the upper basin (Haynes et al. 1984; Valdez et al. 1985). These could be transported in significant numbers by dam operations that regularly inundate and desiccate nursery backwaters. We showed that nursery backwaters were virtually nonexistent in the Lake Powell inflow and that the area contains large numbers of predators that substantially reduce the chances of survival for young fish. Managing lake levels to maximize backwater nursery habitat is not advised, but flow management of the Green River may be possible to reduce the number of young fish transported from nursery habitats in the lower Green and Colorado rivers.

Humpback chub in Cataract Canyon may be remnants of a larger population that once inhabited this region of the upper basin. Before Lake Powell was formed by the closure of Glen Canyon Dam in 1963, Cataract Canyon was 66 km long with 62 major rapids and extended to the confluence of the Dirty Devil River (Dellenbaugh 1908). The only portion of Cataract Canyon not inundated by Lake Powell is the uppermost 19 km with 26 major rapids. Collections of humpback chub from Lake Powell from 1963 to 1967 yielded a large number of "intergrades" that investigators felt reflected hybridization resulting from habitat changes (Holden and Stalnaker 1970, 1975). Chubs captured in Cataract Canyon during this survey had morphological characteristics unique to *Gila cypha*, *G. robusta*, and *G. elegans*, as well as intermediate characters. Monitoring of this population is advised to better delineate its size and distribution. Genetic analysis is also recommended to ascertain the level of hybridization, if it exists.

The suspected bonytails captured and released during this survey are significant findings, because this species is rare and considered biologically extinct in the upper basin. Capturing and holding specimens for propagation could lead to recovery of the original upper basin genetic strain reported by Vanicek (1967) in the Green River. Genetic examination of these specimens is also needed in order to ascertain their species integrity relative to historic specimens or those collected from other regions of the basin.

The decline of razorback suckers in the area in the last 10 years is of great concern; 21 adults were captured in 1980–81 and only one was captured in 1985–88. Although the species seems to be extirpated from CNP, the habitat seems suitable for reintroduction into the area.

The ichthyofauna of the Colorado and Green rivers in and adjacent to CNP was dominated by nonnative species—red shiners, sand shiners, and fathead minnows in shallow shorelines and backwaters and channel catfish and common carp in deep shorelines and the main channel. No practical, large-scale control of nonnative fishes is known for the upper basin, although an inverse relation between spring flow magnitude and numbers of nonnatives was identified in this study (i.e., numbers of nonnatives decreased during years of high spring runoff). The numbers of nonnative fishes, as potential predators and competitors of natives, are likely to persist in the upper basin, with only a temporary reprieve in numbers following high spring flows. Conversely, many nonnative species such as common carp and channel catfish are important prey for bald eagles (*Haliaeetus leucocephalus*) and river otters and may be significant primary or alternative food items.

Fish are a vital aspect of the aquatic and terrestrial ecosystems of CNP. They recycle large quantities of nutrients carried by the rivers and are important food to bald eagles, ospreys (*Pandion haliaetus*), double-crested cormorants (*Phalacrocorax auritus*), mergansers (*Mergus* spp.), belted kingfishers (*Ceryle alcyon*), and river otters. The native species of this area have great significance as members of a river fauna with the highest percentage of species endemism (87%) of any river basin in western North America (Miller 1959). In the face of declining numbers of native fish species, it is imperative that resource agencies recognize the importance of the ichthyofauna of this reach of the upper basin and continue cooperative efforts to better understand and manage this valuable resource.

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